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SIMPLE PROBLEMS

IN

# INDUSTRIAL ARITHMETIC

FOR GRAMMAR GRADES



BY

BRENELLE HUNT



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# **SIMPLE PROBLEMS IN INDUSTRIAL ARITHMETIC**

**FOR**

**GRAMMAR GRADES**

**BY**

**BRENELLE HUNT**

Principal Model School Department of State Normal School,  
Bridgewater, Mass.



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# INTRODUCTION

## THE FUNDAMENTAL PRINCIPLE.

The deflection of all of our mathematical energies into the highway of business is an unfair (though unintentional) discrimination. Processes fundamentally mathematical play a part in most walks of life, particularly in the industries. But industrial vocations are so numerous and varied that there has been justifiable hesitation about using the mathematics of any particular trade for general educational purposes.

What kind of work containing the industrial element are we justified in using? The author believes it is such work as will emphasize the processes which are best adapted to develop the habits upon which vocational efficiency depends, and these operations and processes must find constant application in the doing of useful things, not in solving problems which lead nowhere. We must make such a selection of material as to promote intelligent observation and study of the common things about us which skilled labor has produced, and be very careful that the mathematical processes are not so difficult as to obscure the constructive process involved.

Any mathematics to be classed as "industrial" must bring the pupil into the closest possible contact with the materials studied. *First-hand measurements* must furnish the basis for mathematical computation whenever possible, the measurement and interpretation of *scale drawings*

being next in value. We must deal with such practical things as the economical cutting up of materials, methods of combining for strength and economy, devices for overcoming the natural defects in material used, also the cost of material, wages, estimating, etc.

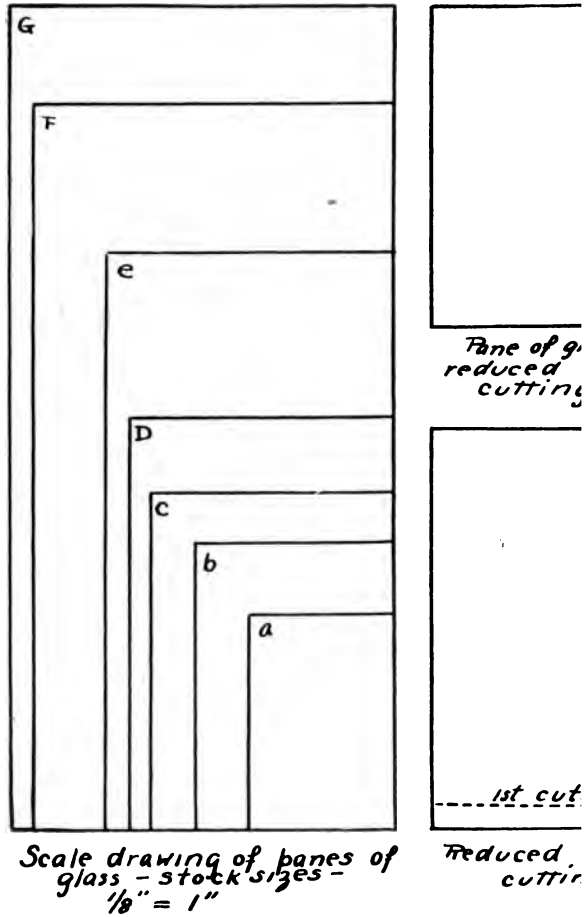
Any series of lessons derived from the trade and prepared for schoolroom use will doubtless be open to criticism by the operatives in the respective trades. Every trade has its short-cut methods of getting results (tricks of the trade) whereby certain things can be more rapidly and easily obtained. The education of children, however, must be along the line of fundamental principles and processes, properly taught, thoroughly drilled, then applied in useful fields of science and industry.

The lessons following are worked out with the intention of utilizing the most available material emphasizing constructive processes, furnishing opportunity for making first-hand measurements, drawing and interpreting simple diagrams, furnishing drill in fundamental operations, and at the same time giving some useful information.

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## LESSON I.—GLASS CUTTING.

[First-hand measurements, simple records, area of rectangles.]

1. The rectangles lettered A to G in the diagram represent stock sizes of glass drawn to a scale of  $\frac{1}{8}$  inch to 1 inch. Measure each rectangle twice for width and twice for length, and decide the dimensions of the panes of glass which they represent. Record the results in the following table and compute the area of each pane in square inches.

Pane.	Size.	Area.
A.....	— in. x — in.	— sq. in.
B.....	— in. x — in.	— sq. in.
C.....	— in. x — in.	etc.

### STOCK SIZES OF GLASS AND RETAIL PRICES, 1910.

6" x 7" @ \$.03	10" x 14" @ \$.09	15" x 30" @ \$.30
6" x 8" @ .03	11" x 14" @ .11	16" x 30" @ .34
6" x 9" @ .03	11" x 15" @ .12	16" x 34" @ .38
7" x 9" @ .04	11" x 17" @ .13	16" x 36" @ .40
8" x 10" @ .05	12" x 18" @ .15	18" x 34" @ .40
8" x 12" @ .06	12" x 20" @ .17	18" x 36" @ .45
9" x 12" @ .06	12" x 24" @ .19	18" x 38" @ .50
9" x 13" @ .07	13½" x 26" @ .24	24" x 26" @ .40
10" x 12" @ .07	13½" x 28" @ .28	26" x 27" @ .50

2. Give orally the area of each pane in the first column.

3. Read the dimensions in this column, expressing each dimension as the fractional part of a foot.

4. How many more square inches in the largest 3-cent size than in the smallest?

5. The 12-cent size gives how many square inches of glass for a cent?

6. Does the 15-cent size give more? How much?

7. Find the areas of the 24-cent and 28-cent sizes and find the difference in area.

8. If it were necessary to have a piece of glass  $16\frac{1}{4}$  in. x  $32\frac{1}{2}$  in. from which stock size would it be cut? Draw a diagram of the pane and indicate by dotted lines where cuts would be made. How many square inches would be wasted? What price would have to be charged for the resulting pane?

9. I have broken the glass front out of a picture frame. It was just  $15\frac{1}{4}$  in. x  $28\frac{1}{2}$  in. From which of the above stock sizes would it be cut? Diagram. How many square inches wasted?

10. Select the stock size from which the following can be cut most economically. Diagram each. Compute the amount of waste. Decide the cost:—

(a)  $10\frac{1}{2}$  in. x  $15\frac{3}{8}$  in.

(d) 24 in. x  $11\frac{1}{2}$  in.

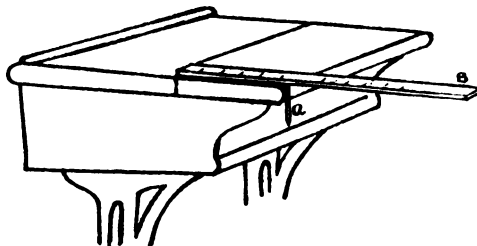
(b)  $6\frac{1}{2}$  in. x  $9\frac{3}{4}$  in.

(e) 25 in. x 13 in.

(c) 9 in. x  $13\frac{3}{4}$  in.

(f)  $16\frac{3}{8}$  in. x 10 in.

## LESSON II.—THE SCHOOL DESK.



To the Teacher.—The following lesson gives a chance for the class to make first-hand measurements without leaving their seats. Every child can be at work at the same time. No two desk tops will be made of boards exactly the same width, and pupils should make a study of their own desks before using the dimensions furnished in the following lessons. We are here furnished with an excellent lesson in addition and subtraction of fractions ranging from halves to sixteenths.

To the Pupils.—If you will examine the top of your desk very carefully, you will find that two or three boards have been used in making what seems, at first glance, to be one very wide board, the width of the desk top or lid. These boards have been fitted together with great care, so that you may find it difficult to discover their edges. They were glued and placed in what resembles a large vise, which held them tightly together until the glue was perfectly dry. The boards used vary greatly in width, and are put together so as to waste as little as possible.

### Problems.

1. Measure the length and width of your desk, taking into consideration the curved edges. In like manner find the width of some of the single boards used. Use your pencil and ruler, as shown by *a* and *b* in the diagram.

2. An open box desk, like that in the sketch, has a top 24 inches long (measuring from left to right), and 16 inches wide (measuring from front

to back). All boards must be cut how long? Give some reasons why the width of boards varies so much.

**3.** The cabinet-maker at work on desks of this size may have selected a board  $12\frac{7}{8}$  in. wide throughout. How wide a board must be put with it to give the proper width?

**4.** Select boards which must be combined with each of the following to make the proper width:  $2\frac{7}{8}$  in.,  $9\frac{5}{16}$  in.,  $6\frac{1}{8}$  in.,  $9\frac{1}{16}$  in.,  $5\frac{1}{8}$  in.,  $9\frac{1}{8}$  in.

**5.** Give the width of boards which would combine with each of the following to make a 13-inch desk top:  $9\frac{1}{8}$  in.,  $5\frac{3}{16}$  in.,  $7\frac{7}{8}$  in.,  $3\frac{1}{16}$  in.,  $8\frac{9}{16}$  in.,  $11\frac{7}{8}$  in.

Note.—Boards rarely come of just the right width to make the required top; strips have to be sawed off or planed off. The workman can economize stock how?

**6.** If the two boards selected for a 16-in. top are  $12\frac{7}{8}$  in. and  $5\frac{1}{4}$  in., how much will have to be sawed or planed from one of the boards to give the proper width?

Note.—In making desks with wider tops, or lids of the "lifting lid" style of desk, three boards are occasionally used. Give reasons why this is undesirable and not the usual custom.

**7.** How wide a board will have to be combined with the two in each of the following groups to make a lid 20 inches wide?

- (a)  $5\frac{3}{8}$  in.,  $10\frac{1}{8}$  in., ? in.      (d)  $7\frac{1}{2}$  in.,  $6\frac{5}{8}$  in., ? in.  
 (b)  $7\frac{7}{8}$  in.,  $9\frac{3}{4}$  in., ? in.      (e)  $6\frac{3}{4}$  in.,  $7\frac{1}{8}$  in., ? in.  
 (c)  $5\frac{5}{16}$  in.,  $3\frac{7}{8}$  in., ? in.      (f)  $4\frac{5}{8}$  in.,  $5\frac{1}{16}$  in., ? in.

**8.** The following widths of boards are hand:  $6\frac{3}{4}$  in.,  $6\frac{5}{8}$  in.,  $7\frac{1}{2}$  in.,  $7\frac{1}{16}$  in.,  $8\frac{1}{8}$  in.,  $8\frac{1}{4}$  in., in.,  $8\frac{7}{8}$  in.,  $9\frac{1}{16}$  in.,  $9\frac{1}{4}$  in.,  $9\frac{5}{8}$  in.

Select the most economical board from the above widths to combine with each of the following in making 16-in. desk tops: (a)  $12\frac{7}{8}$  in., (b)  $9\frac{1}{8}$  in., (c)  $8\frac{9}{16}$  in., (d)  $11\frac{7}{8}$  in., (e)  $13\frac{5}{16}$  in., (f)  $9\frac{1}{2}$  in.

**9.** Decide how much will have to be removed from each of the following combinations to give exactly 16-inch tops:—

- (a)  $9\frac{1}{2}$  in., and  $7\frac{7}{8}$  in. (c)  $8\frac{1}{2}$  in. and  $10\frac{3}{8}$  in.  
 (b)  $8\frac{3}{4}$  in. and  $11\frac{1}{8}$  in. (d)  $12\frac{1}{8}$  in. and  $4\frac{3}{4}$  in.  
 (e)  $11\frac{7}{8}$  in. and  $5\frac{3}{4}$  in.  
 (f) 8 in. and  $6\frac{1}{2}$  in. and  $3\frac{7}{8}$  in.

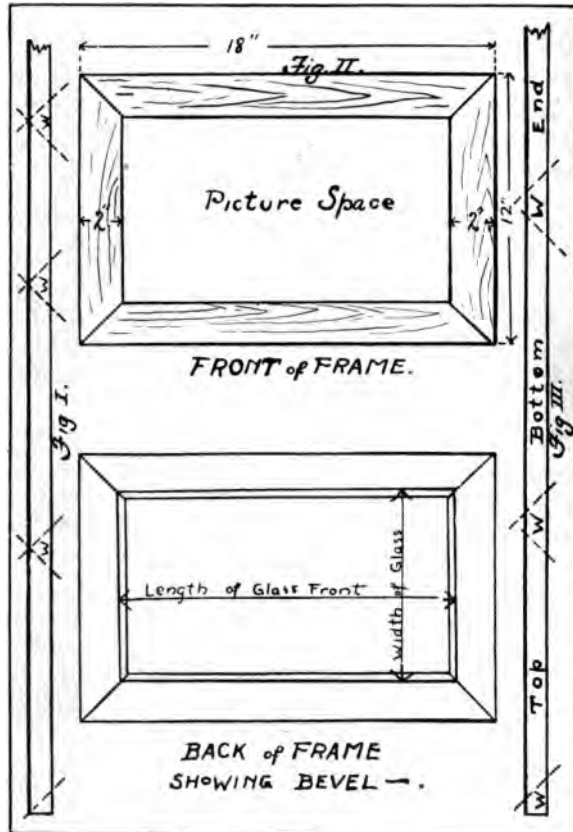
**10.** How much from each of the following if 13-in. tops are desired? (a)  $7\frac{1}{4}$  in. and  $8\frac{1}{8}$  in., (b)  $9\frac{7}{8}$  in. and  $5\frac{3}{8}$  in., (c)  $4\frac{1}{4}$  in. and  $8\frac{1}{2}$  in. and  $2\frac{1}{4}$  in., (d)  $8\frac{1}{8}$  in. and  $5\frac{1}{2}$  in.

**11.** If the workman has chosen a  $6\frac{1}{2}$ -in. board and a  $10\frac{7}{8}$ -in. board for the top of a 16-inch desk, how much must be removed? If taken from the  $10\frac{7}{8}$ -in. board, how wide will it be? If taken from the narrower, how wide will it be left?

**12.** From each of the following combinations intended for a 13-inch desk, have the superfluous width cut from the narrower board. Tell how wide a strip must be removed and how wide it left the board:—

- (a)  $4\frac{1}{4}$  in. and  $9\frac{5}{8}$  in. (d)  $5\frac{7}{8}$  in. and  $7\frac{7}{8}$  in.  
 (b)  $7\frac{3}{8}$  in. and  $6\frac{1}{4}$  in. (e)  $10\frac{1}{4}$  in. and  $4\frac{1}{8}$  in.  
 (c)  $8\frac{1}{2}$  in. and  $4\frac{7}{8}$  in. (f)  $9\frac{7}{8}$  in. and  $3\frac{5}{8}$  in.

Note.—By noting the width of one board on a two-foot rule (illustration,  $10\frac{3}{4}$  inches), then laying a foot rule on top so that the end is at the  $10\frac{3}{4}$ -inch mark, and noting the width of the second board on the foot rule (illustration,  $3\frac{7}{8}$  inches) we can, by looking directly under the  $3\frac{7}{8}$ -inch mark, see on the two-foot rule the sum, namely,  $14\frac{5}{8}$  inches. One-half of the class can thus “check” the work of those using pencils and paper in all problems in this lesson.



### LESSON III.—MAKING PICTURE FRAMES.

1. Fig. I. shows how a strip of picture frame moulding might be cut to give the four sides of a frame. What becomes of pieces marked *w*? The heavy line indicates the *thick* edge of the moulding. Which part of the frame would this form?

2. Draw lengthwise of your paper (to scale of  $\frac{1}{16}$  in. to 1 in.) a strip of moulding 8 ft. long. Indicate as in Fig. I. exactly where and how it would be sawed to make the frame in Fig. II.

3. Mark the dimensions along the outer edges. Compute the total length of moulding used.

4. If worth 8 cents per running foot, what would it cost? What if worth  $6\frac{1}{2}$  cents?  $5\frac{1}{4}$  cents?

5. Without making diagrams, compute the length of moulding required to make frames of the following dimensions: (a) 14 in. x 9 in.; (b) 21 in. x 16 in.; (c)  $15\frac{1}{2}$  in. x 12 in.; (d)  $11\frac{1}{4}$  in. x  $9\frac{1}{2}$  in.

6. The cutting of moulding for picture frames requires much care and considerable skill. All edges must be absolutely smooth and perfect. Compare the method of cutting indicated in Fig. I. and Fig. III. Which would be more likely to result in finished work? Which would take more stock (moulding)?

7. Compute the amount of moulding required for picture frames whose outside measurements are as follows. Allow 4 in. for waste in cutting, i. e., an inch at each cutting, as in Fig. III. Express the result in feet and inches; also as feet and fractions of a foot; (a) 12 in. x 15 in.; (b) 9

in. x  $14\frac{1}{2}$  in.; (c)  $13\frac{1}{2}$  in. x 16 in.; (d)  $13\frac{1}{2}$  in. x  $17\frac{1}{2}$  in.; (e) 8 in. x  $15\frac{3}{4}$  in.; (f)  $15\frac{1}{2}$  in. x  $18\frac{3}{4}$  in.

**8.** Sketch the frames indicated by the following dimensions; mark the dimensions on the sketch; ascertain the exact size of the picture space:—

- (a) 8 in. x 13 in., using  $1\frac{1}{4}$ -in. moulding.
- (b) 12 in. x 15 in., using  $2\frac{1}{4}$ -in. moulding.
- (c)  $12\frac{1}{2}$  in. x  $16\frac{1}{2}$  in., using 2-in. moulding.
- (d)  $13\frac{1}{2}$  in. x 15 in., using  $2\frac{3}{8}$ -in. moulding.

**9.** Examine any fragments of moulding or the backs of any available picture frames, and measure the depth of *bevel* into which the glass front is set.

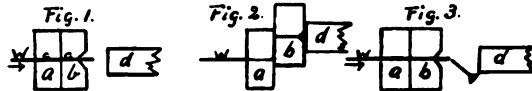
If the bevel in Fig. II. is  $\frac{3}{8}$  in. deep, how long must the glass be if it fits exactly? How wide?

**10.** Consult the table showing sizes of glass, and select the stock size from which this glass front could be cut most economically.

**11.** If the "picture space" in a given frame is 12 in. x 15 in., and the bevel is  $\frac{1}{4}$  in. deep, how long and how wide must the glass be cut? Choose the stock size from table in Lesson I., and decide whether it must be cut or not. If so, describe how it shall be cut. Diagram.

**12.** A picture frame is constructed of  $2\frac{1}{2}$ -in. stock, outside length  $21\frac{1}{2}$  inches, and width 15 inches. (a) Compute the total length of moulding used, allowing 4 inches waste. (b) How much would remain if cut from a 10 foot strip? (c) Compute size of picture space. (d) If bevel is  $\frac{1}{4}$  in., how large a glass is needed? (e) Select the nearest size, draw diagram to illustrate cutting. (f) How much of the stock size pane was wasted?

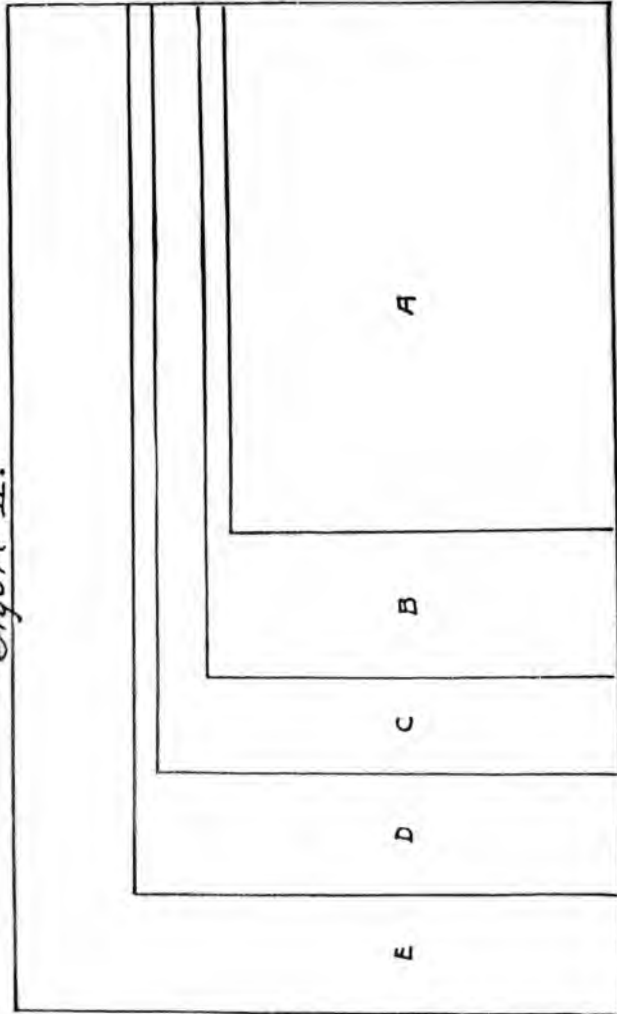
#### IV. THE MANUFACTURE OF SCREWS AND PINS.



Screws and pins are all made from metal wire of appropriate sizes, cut off the right length, headed, and pointed by machinery. These machines do this work automatically; the man in charge merely feeds and oils them. One man can look after from ten to fifteen machines. In Fig. 1 (a) is a fixed block of tempered steel; (b) is a movable block. The wire feeds in through the hole (c c), extending a short distance beyond the face of the block (b), which moves upward, as shown in Fig. 2, cutting the wire off the length required. At the same time a hammer (d) strikes the exposed end of the wire, forcing it into the depression in (b), which gives shape to the head of the screw. As the block (b) shoots quickly down, the blank screw is pushed out, and more wire feeds in, ready to be cut and headed.

1. If one machine cuts and heads 90 small screws in a minute, how many would be made in 1 hour? How many in one 8-hour day?
2. If one man looks after 11 such machines, how many blank screws constitute his day's work? How many do you think could have been made by hand before the days of machinery?
3. Screws are sold by the gross. How many gross turned out by this man in a day?
4. How many gross by a man who looks after 12 machines, each averaging 105 per minute?
5. Compute the output of each man as follows:—

	Number of Machines.	Average Number per Minute.	Total per Hour.	Total per 8 Hour Day.	How Many Gross?
Mr. Jones.....	9	95	?	?	?
Mr. Sampson...	12	110	?	?	?
Mr. Moore.....	11	90	?	?	?

*Figure II.**Stock size business cards.*

size of a card. They are all to be cut as shown in Fig. I. the long way of the card running length-wise of the sheet of cardboard.

State the exact size of card A, and tell how many could be cut from a single sheet 22 in. x 28 in.

4. Dimensions of B? How many from one 22 in. x 28 in.

5. Dimensions of C? How many from one 22 in. x 28 in.?

6. Dimensions of D? How many from one 22 in. x 28 in.?

7. Dimensions of E? How many from one 22 in. x 28 in.?

8. How many sheets of 22-in. x 28-in. cardboard must be cut up if 500 cards like A are ordered?

9. How many for 500 of B?

10. How many for 1,000 of C?

11. How many for 1,000 of D?

### Part 3.

The following table contains the trade name and size of different grades of paper from which letter paper, bill heads, etc., are cut.

TRADE NAME.	Size.	Area in Sq. In.	Area in Sq. Ft.	TRADE NAME.	Size.	Area in Sq. In.	Area in Sq. Ft.
Flat letter....	10"x16"	?	?	Super royal..	20"x28"	?	?
Flat packet ..	12"x19"	?	?	Double cap...	17"x28"	?	?
Demy.....	16"x21"	?	?	Imperial.....	23"x31"	?	?
Flat cap.....	15"x19"	?	?	Double royal..	"42"x38"	?	?
Double letter.	16"x20"	?	?	Atlas .....	26"x33"	?	?
Folio.....	17"x22"	?	?	Antiquarian..	31"x53"	?	?
Double folio..	22"x34"	?	?	Cardboard....	22"x28"	?	?
Packet folio..	19"x24"	?	?	Medium.....	18"x23"	?	?

**Written Problems.**

1. Fill in such part of the table as shall be required.

2. Commercial note heads are  $5\frac{1}{2}$  in. x  $8\frac{1}{2}$  in. Draw a diagram, showing how they would be cut from a large folio sheet. How many can be cut from one sheet?

3. How many large sheets must be cut up to make 100 note heads?

4. Royal packet note heads are 6 in. x  $9\frac{1}{2}$  in. From which of the above sizes can it be cut without waste? Diagram each.

5. How many large sized sheets of Flat Packet would have to be cut up to make 1,000 of these note heads?

6. Decide from what stock size each of the following can be cut without waste, and how many could be cut from one large sheet:—

(a) Bill heads  $8\frac{1}{2}$  in. x 7 in.

(b) Regular statements  $5\frac{1}{2}$  in x  $8\frac{1}{2}$  in.

7. Decide which of the above stock sizes you would cut up to get the following, and how many sheets must be cut to get 1,000:—

(a) Letter heads  $8\frac{1}{2}$  in. x 11 in.

(b) Letter heads 8 in. x  $10\frac{1}{2}$  in.

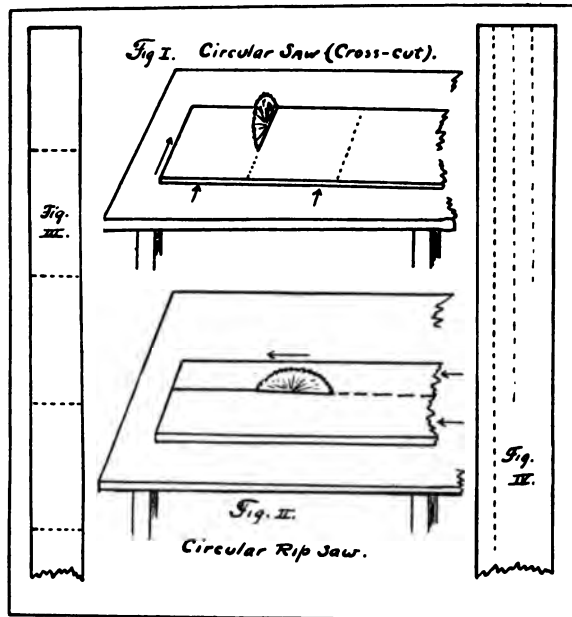
(c) Note heads  $5\frac{3}{4}$  in. x 9 in.



LEARNING TO BE ACCURATE.

This class spends every alternate week in the machine shop,  
where accuracy counts.

[By permission of the United Shoe Machinery Co.]



## **LESSON VI.—THE CIRCULAR SAW.**

The accompanying simple sketches illustrate circular saws operated by machinery and revolving through a slot in a bench. Both "cross cut" and "rip saws" are made in this style. Where have you seen them used? What are their advantages? Why is the carpenter obliged to depend largely on the slower hand saw?

### **Oral Problems.**

1. If a 10-ft. board were to be cut up into 2-foot lengths, as in Figures I. and III., how many strips would there be? How many times would the board have to be sawed?

2. How many 6-in. pieces could be obtained by sawing a 12-foot board in the same way? How many cuts would have to be made?

3. If you wanted to get 3-ft. pieces and had the following length boards at hand, which would you select? Why? 8-foot? 9-foot? 10-foot? 12-foot? 14-foot?

4. How many strips approximately 2 in. wide could be obtained by dividing a 12-inch board by the circular "rip saw" as shown in Figures II. and IV.? How many times would it be necessary to saw the board?

### **Written Problems.**

1. In sawing a 10-ft. board into 27-in. lengths, how many could be obtained? How much waste? Diagram.

2. Would it be more or less economical to saw such lengths from an 11-foot board? What is the waste per board in the latter case?

3. Decide which of the following boards would saw up into 32-in. lengths with the least waste. State the exact amount wasted in each case. Lengths: 12 feet, 13 feet, 14 feet.

4. How many  $2\frac{1}{4}$ -ft. lengths can be obtained from a 14-ft. plank?

5. If many  $2\frac{1}{4}$ -ft. lengths were desired, find which of the following board would saw up practically without waste: 8-ft., 9-ft., 10-ft., 12-ft., 13-ft., 15-ft., 16-ft., 18-ft.

**Note.**

What kind of a saw is used in sawing boards lengthwise? How do its teeth differ from those of a cross-cut saw?

Boards must be sawed lengthwise in order to get narrow strips for the different kinds of moulding. (See Figs. II. and IV.) The circular power saw works rapidly and accurately, enabling a single workman to accomplish many times as much as would be possible with a hand rip saw.

In problems 6 to 10 no account is taken of the "saw scarf" or narrow strip of wood destroyed by the saw as it passes through. As the class becomes acquainted with the general process this is corrected, as in problems 11 to 14.

6. How many strips  $2\frac{1}{2}$  in. wide could be cut from a 12-inch board? Make a diagram, showing by carefully drawn dash lines the paths of the saw. (See Fig. IV.)

7. Find a common width of board in which there would be little or no waste.

8. Into how many  $2\frac{1}{4}$ -in. strips will a 9-inch board saw?

9. Decide which of the following boards would saw up into  $1\frac{3}{8}$ -in. strips with the least waste. State the fraction of a strip wasted in each case: Width of boards: 8 inches, 9 inches, 10 inches, 12 inches.

10. Cut a 10-in. board up into  $1\frac{3}{8}$ -in. strips. Number of strips? Fraction of a strip

remaining? This fraction of a strip would be about how many inches wide?

**11.** If to the width of the strip in problem 10 we add the width of the "saw scarf" ( $\frac{1}{8}$  in.), how wide a strip of board is used to get the  $1\frac{3}{4}$ -in. strip desired?

**12.** How wide a strip left, then, after the five strips had been sawed?

**13.** In sawing a 10-in. board into  $2\frac{3}{8}$ -in. strips, add the width of saw scarf to the width of strip called for as above, and decide the number of such strips obtained.\*

**14.** If a 14-in. board is to be sawed into strips at least  $1\frac{5}{8}$  inches wide, and the saw is the same thickness as above, how many such strips could be obtained?

**15.** In order to do good clean work the teeth of a saw should travel nearly 9,000 feet per minute. How many miles would this be? (Express remainder as a decimal.)

**16.** How many feet per second?

**17.** In order to secure this speed, how many revolutions would a small saw make compared with a saw whose diameter is larger?

**18.** If the rim of a saw is 25 in. around, how far would a tooth travel in one revolution? How many revolutions must it make to go 9,000 feet?

**19.** If it has a 44-in. rim, how many revolutions would it make to attain the standard speed?

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\* Occasionally, of course, there will be one less saw scarf than the number of resulting strips, but the method of computing results is sufficiently accurate.

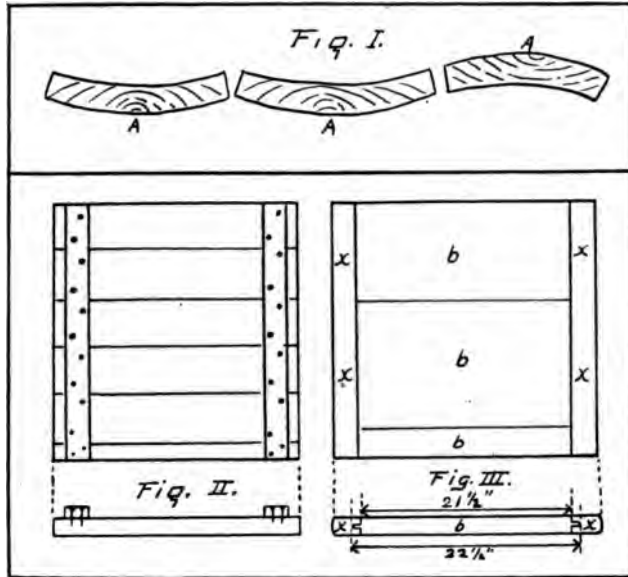


Fig. I. represents the ends of three boards which have warped. The drying of the sap, when the green wood was exposed to the atmosphere, caused the board to shrink. Boards are sawed from logs, and the side of the board nearest the outside of the log contains more sap than the side toward the centre or heart of the log. The warping is therefore away from the centre in each case (see a a in Fig. I.).

Fig. II. shows one way of preventing warping. Two "cross cleats" are screwed firmly to the boards across the "grain." This is a cheap and easy method which can be used in box covers, storm doors, etc.

Fig. III. shows a neater and better way of doing the same thing by means of "end cleats." The ends of the centre boards (b b) are cut so as to leave a projecting "tongue," which fits into a "groove," cut in the inner edge of the end cleats (x x). They are glued firmly together, and the inner boards are thus kept from warping. This method is used in bread boards, desk lids, paneled doors, etc.

## **LESSON VII.**

### **A SIMPLE STUDY IN THE USE OF LUMBER.**

#### **Problems.**

A box cover like Fig. II. is to be made from 4-in. stock, i. e., boards 4 inches wide. It is to be 3 feet long and 2 feet wide, with cross cleats of the same stuff.

1. How many strips of suitable length can be sawed from a 12-ft. board?

2. How many strips will be needed for the width required?

3. How many boards will have to be ordered to make the cover, cleats and all?

4. Use similar stock and construct a box cover 28 inches long and 18 inches wide. Make a drawing, putting in all dimensions as before. Decide the number of strips needed to obtain the required width. How much will have to be removed from the last strip to keep it exactly 18 inches wide? How is this done?

5. What is the total number of running feet of board needed for the above piece of work? (Count any fraction as an additional foot.) Add to this the length needed for the two cross cleats. What length of board would be required to do the entire piece of work? Will you buy one or more boards? What length in each case?

6. Four-inch cross cleats are heavier than necessary. If one of them were sawed lengthwise through the centre with a rip saw, it would give cleats of what width? Compute the entire

length of board needed to do the entire job by this latter method.

### **Making a Bread Board**

Bring one or more bread boards to school. Measure their widths across the grain of the centre boards. Boards 15 inches to 20 inches wide would soon warp and be useless unless made as in Fig. III.

**7.** If the two middle boards are  $21\frac{1}{2}$  in. long on the upper side, how long must they have been sawed originally to have allowed for projecting half-inch tongues?

**8.** The end cleats are  $1\frac{3}{8}$  in. wide. Look carefully at the sketch, and compute the entire length of the board.

**9.** The centre is made of two wide boards glued tightly together and smoothed down until they look like one very wide board. The width of each is  $7\frac{1}{4}$  in. and  $10\frac{5}{8}$  in. respectively. How wide is the entire board?

**10.** In constructing a bread board 18 in. wide, one board  $8\frac{3}{4}$  in. is used. How wide must the other be?

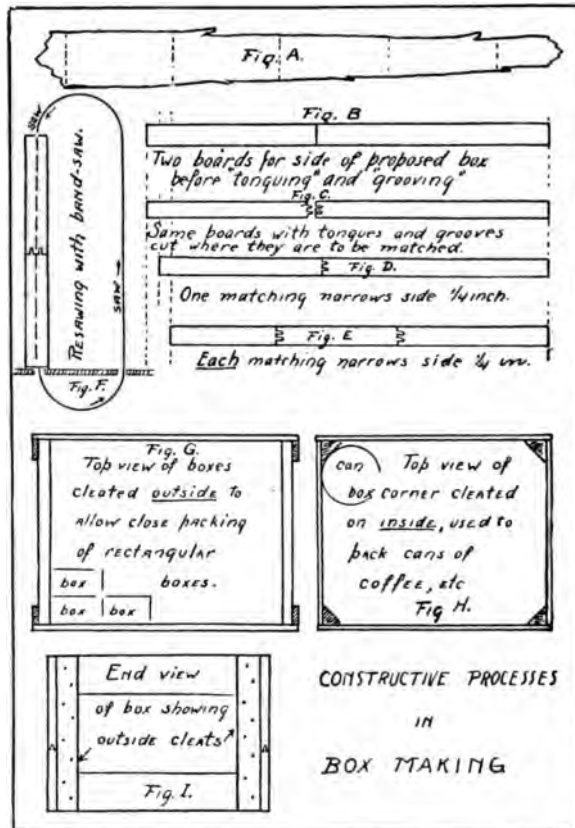
**11.** How long a bread board could be made from boards whose faces are  $19\frac{1}{4}$  in. long after the tongues have been cut, and which are held together by  $2\frac{1}{4}$ -in. end cleats?

**12.** If the centre board were  $18\frac{1}{4}$  in. long before the half-inch tongues were cut and  $2\frac{1}{4}$ -in. end cleats were used, what would be the total length?

**13.** Compute the full length if the boards were 20 in. long at first, had tongues  $\frac{3}{8}$  in. cut, and were finally held together by  $1\frac{7}{8}$ -in. end cleats.



WORKING OUT A PROBLEM IN THE CARPENTER  
SHOP.



## LESSON VIII.—THE MANUFACTURE OF WOODEN BOXES.

### SAWING-UP PROBLEMS.

When the rough boards are brought into the mill they are thrown on to a bench and cut by a circular "cross cut" saw into right length for use. (See Fig. A.)

1. How many boards for sides  $15\frac{1}{2}$  in. long could be cut from a 12-ft. board?

2. How many  $13\frac{1}{4}$ -in. box ends could be cut from the same length board?

3. Box boards vary very much in length. How many  $23\frac{1}{2}$ -inch lengths can be cut from boards of the following lengths: 14 feet, 15 feet, 18 feet? How much waste in each case?

4. How many  $14\frac{1}{2}$ -in. lengths could be cut from boards running 13 feet, 6 inches? 14 feet, 4 inches? 15 feet?

### PLANING PROBLEMS.

5. The boards are next run through a planing machine, which reduces them from  $1\frac{1}{2}$  in. to  $1\frac{3}{8}$  in. How much was taken off each side? If reduced from  $1\frac{1}{4}$  in. to  $1\frac{3}{8}$  in., how much was planed off each side?

### SIDING-UP PROBLEMS.

Certain men spend their entire time putting together boards for the sides and ends of boxes. One man sometimes spends his whole time making sides for one kind of box.

6. Box boards vary greatly in width. How wide a side could be made by the following three boards placed edge to edge:  $5\frac{1}{2}$  in.,  $8\frac{1}{4}$  in.,  $6\frac{5}{16}$  in. wide?

Most boxes are made of "matched" boards, that is, boards in which "tongues" and "grooves" have been cut. Study Figs. B, C, D, and E

very carefully. Which board is really narrowed, the one which has been tongued (on the left) or the one on the right which has been grooved? When the tongues and grooves are  $\frac{1}{4}$  of an inch deep and the two boards are pushed together, they will cover in all  $\frac{1}{4}$  of an inch less space than they did as shown in Fig. B.

**7.** How wide a side would the following two boards make without tonguing and grooving:  $11\frac{1}{8}$ ,  $6\frac{3}{4}$  in. wide? How wide a side after "matching?"

**8.** Compute the width of the following sets before and after matching if  $\frac{1}{4}$ -in. tongues and grooves are used:—

(a)  $13\frac{3}{8}$  inches and  $10\frac{5}{16}$  in. wide.

(b)  $9\frac{1}{4}$  in. and  $7\frac{1}{16}$  in. wide.

(c)  $5\frac{7}{8}$  in. and  $8\frac{1}{2}$  in. wide.

**9.** When he puts three boards together for a side, he has to allow  $\frac{1}{4}$  of an inch for each of the two matchings (Fig. E). How wide a side can be made from the following sets of three before and after matching?

(a)  $5\frac{1}{2}$  in.,  $6\frac{3}{4}$  in., 9 in. wide.

(b)  $8\frac{1}{8}$  in.,  $5\frac{3}{8}$  in.,  $7\frac{1}{16}$  in. wide.

(c)  $3\frac{3}{4}$  in.,  $4\frac{1}{2}$  in.,  $8\frac{1}{4}$  in. wide.

(d) 4 in.,  $5\frac{7}{8}$  in.,  $3\frac{1}{4}$  in. wide.

**10.** Mr. A is "siding-up" boxes whose sides must be just  $20\frac{1}{2}$  in. wide. The boards are to be tongued and grooved after leaving his bench. They will shrink how much due to matching if three boards are used? How much must he add to the required width ( $20\frac{1}{2}$ )? How many inches wide must they be before matching if three boards are used?

**11.** If he uses the following three boards, how

much will have to be sawed off to make them the right width?

- (a) 10 in.  $5\frac{1}{2}$  in.,  $7\frac{1}{8}$  in. wide.
- (b)  $9\frac{1}{2}$  in.,  $4\frac{7}{8}$  in.,  $8\frac{3}{4}$  in. wide.
- (c)  $5\frac{3}{8}$  in., 10 in.,  $6\frac{3}{4}$  in. wide.
- (d)  $8\frac{1}{4}$  in.,  $7\frac{1}{2}$  in.,  $6\frac{1}{8}$  in. wide.

**12.** Mr. B is making sides which have to be 13 inches wide. If he uses two boards for most of them, what must be their combined width *before* matching?

**13.** How wide a strip will have to be trimmed off the edge of one of them if the following widths are used?

- (a)  $7\frac{1}{2}$  in. and  $7\frac{1}{4}$  in. wide.
- (b)  $8\frac{7}{8}$  in. and 6 in. wide.
- (c)  $9\frac{1}{4}$  in. and  $5\frac{1}{8}$  in. wide.
- (d)  $8\frac{1}{4}$  in. and  $5\frac{7}{8}$  in. wide.

After the boards have been cut the right width for sides and ends of boxes, they are taken to a machine which tongues and grooves, then to a band saw (see Fig. F) which splits them lengthwise, making the two sides or ends of a box out of the one set of boards.

**14.** If the boards were  $1\frac{3}{8}$  in. thick before being "resawed" how thick would they be afterward if the saw cut exactly in the centre?

**15.** In sawing the saw cuts and destroys its own thickness of the board, grinding it into sawdust. If we subtract the thickness of this saw-scarf ( $\frac{1}{8}$  in.) from the original thickness of the boards and then divide by 2, we shall get boards how thick?

**16.** If the sides to be "resawed" are  $1\frac{1}{2}$  inches thick, and the same saw is used, how thick will the resulting sides be?

**17.** How thick if the boards were  $1\frac{1}{4}$  in. thick at first?

In ordering boxes the inside dimensions are always given. These almost always contain fractional parts of an inch, as they must fit the enclosed boxes, cans, etc., exactly to avoid breakage. Study Fig. H.

**18.** A plain box (like Fig. H without cleats) is ordered. Its inside length is to be 11 inches. If the ends are to be  $\frac{1}{2}$ -in. stock (i. e.,  $\frac{1}{2}$  in. in thickness) how long will the sides have to be sawed?

**19.** Find how long the sides of the following boxes will have to be sawed:—

- (a) Inside length,  $22\frac{1}{2}$  in.; ends,  $\frac{1}{8}$  in. thick.
- (b) Inside length,  $34\frac{1}{4}$  in.; ends,  $\frac{1}{8}$  in. thick.
- (c) Inside length,  $30\frac{5}{8}$  in.; ends,  $\frac{5}{8}$  in. thick.
- (d) Inside length,  $31\frac{3}{4}$  in.; ends,  $\frac{7}{8}$  in. thick.

**20.** Study Fig. G. which is cleated outside. If the ends are both  $\frac{3}{8}$  in. thick and the cleats 1-2 inch thick, how long would the sides have to be sawed, provided the inside length is to be  $17\frac{1}{2}$  in.?

**21.** How long must sides of the following boxes be cut?

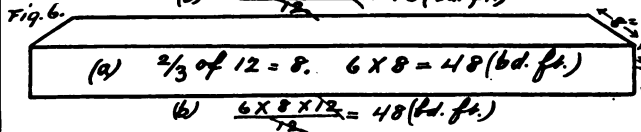
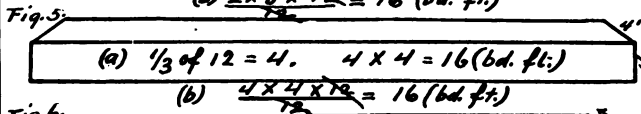
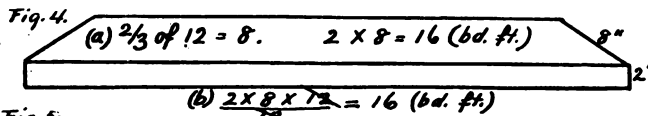
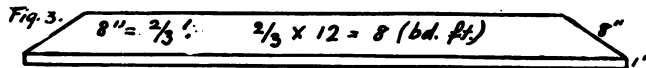
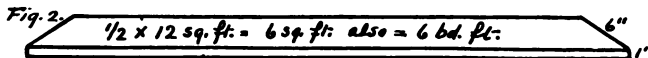
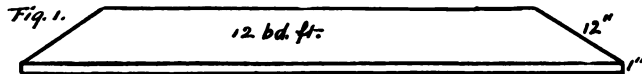
- (a) Inside length,  $22\frac{5}{8}$  in.; ends,  $\frac{3}{4}$  in. thick; outside cleats,  $\frac{1}{2}$  in. thick.
- (b) Inside length, 28 in.; ends,  $\frac{3}{4}$  in. thick; outside cleats,  $\frac{3}{8}$  in. thick.
- (c) Inside length,  $27\frac{7}{8}$  in. ; ends,  $\frac{1}{6}$  in. thick; outside cleats,  $\frac{1}{2}$  in. thick.



Pupils making first hand measurements of heavy timber  
and computing the number of board feet.

[See Lesson IX.]

Computing Board Measure (B.M.).  
 Showing two methods (a) + (b).  
 (Each piece 12 ft. long)



## **LESSON IX.—BOARD MEASURE.**

**1.** If a board is 1 ft. wide and 12 ft. long there would be how many square feet in its top surface? (See Fig. 1.) If 14 ft. long? If 15 ft.?

**2.** How does the number of board feet in any 12-in. board (1 in. or less in thickness) compare with the number of running feet?

**3.** How does the number of board feet in a 6-in. board (1 in. or less in thickness) compare with the number of running feet? (Fig. 2.) An 8-in. board? (Fig. 3.)

**4.** How many board feet in 6-in. boards of the following lengths? 10 ft., 18 ft., 15 ft., 16 ft., 20 ft., 12 ft., 13 ft.

**5.** How many board feet in 4-in. boards of the following lengths? 8 ft., 18 ft., 20 ft., 16 ft., 15 ft., 12 ft., 13 ft.

**6.** Explain what is meant by 2" x 3" stock, 3" x 4", 4" x 4", 2" x 8".

**7.** How wide is the "face" of the board in each of the above?

**8.** Compute the area of the face of each of the above if each is 16 ft. long.

**9.** Compute the area of the face of an 8-in. plank, 12 ft. long. How many board feet does it contain if 2 in. thick? Fig. 4 (a).

**10.** The carpenters' method is shown in Fig. 4 (b). Compute by this method the board feet in a similar plank 16 ft. long.

**11.** Area of face of a 4" x 4" timber, 12 ft. long? Fig. 5 (a). Number of board feet?

**12.** Use the carpenters' method, Fig. 5 (b), and find the number of board feet in a similar timber 15 ft. long.

**13.** Area of the broad side of a 6" x 8" timber,

12 ft. long? Fig. 6 (a). Number of board feet?

**14.** Use the carpenters' method, Fig. 6 (b), and find the number of board feet in a similar timber 20 ft. long.

**15.** How does the number of board feet in any 12-ft. board compare with the number of inches in its width? (Fig. 1, 2, 3.)

**16.** How does the number of board feet in any 12-ft. timber compare with the product of its width by thickness? (Fig. 4, 5, 6.)

### Oral Practice.

Compute the number of board feet in each of the following:—

(a) 6-in. board, 16 feet long. 1 board. 20 boards. 15 boards.

(b) 2" x 3" studding, 12 ft. long. 1 pc. (piece). 6 pc. 10 pc.

(c) 3" x 3" stock, 16 ft. long. 1 pc. 5 pc. 7 pc.

(d) 4" x 4" stock, 15 ft. long. 1 pc. 3 pc. 5 pc.

(e) 2" x 8" plank, 12 ft. long. 1 pc. 9 pc. 40 pc.

(f) 6" x 8" timber, 12 ft. long. 1 pc. 2 pc. 10 pc.

### Written Problems. (Continued.)

**17.** How many board feet in 5 pc. of 2" x 8" stock, 12 ft. long?

$$\text{III. } \frac{5 \times 2 \times 8 \times 12}{12} = 80 \text{ (no. of board ft.)}$$

Compute the number of board feet in each of the following lots of lumber:—

**18.** 10 6-in. boards, 12 ft. long.

**19.** 40 4-in. boards, 10 ft. long.

20. 15 2" x 3" strips, 14 ft. long.  
 21. 30 2" x 8" rafters, 16 ft. long.  
 22. 14 3" x 4" stock, 12 ft. long.  
 23. 5 4" x 4" stock, 15 ft. long.  
 24. 12 6" x 6" timbers, 18 ft. long.  
 25. 8 6" x 8" girders, 18 ft. long.  
 26. 7 8" x 12" timbers, 16 ft. long.

### Computing the Cost of Lumber.

The price of all kinds of lumber is quoted as a certain number of dollars per thousand, i. e., per thousand board feet.

(Ill. a): 1,260 board ft. @ \$30 per M. (1,000).  
 $1.26 = \text{No. of 1,000. } 1.26 \times \$30 = \$37.80.$

(Ill. b): 86 ft. @ \$35 M.  
 $.086 = \text{No. of 1,000. } .086 \times \$35 = \text{cost.}$

27. Compute the cost of 2,500 bd. ft. @ \$30 M.  
 28. Compute the cost of 800 bd. ft. @ \$32 M.  
 29. Compute the cost of 450 bd. ft. @ \$10 M.  
 30. Compute the cost of 1,060 bd. ft. @ \$12 M.  
 31. Compute the cost of 160 bd. ft. @ \$35 M.  
 32. Compute the cost of 96 bd. ft. @ \$36 M.  
 33. Copy the following bill. Compute amounts and substitute figures for the question marks throughout:—

BRIDGEWATER, MASS., December 1, 1910.

WILLIAM R. RUSSELL,

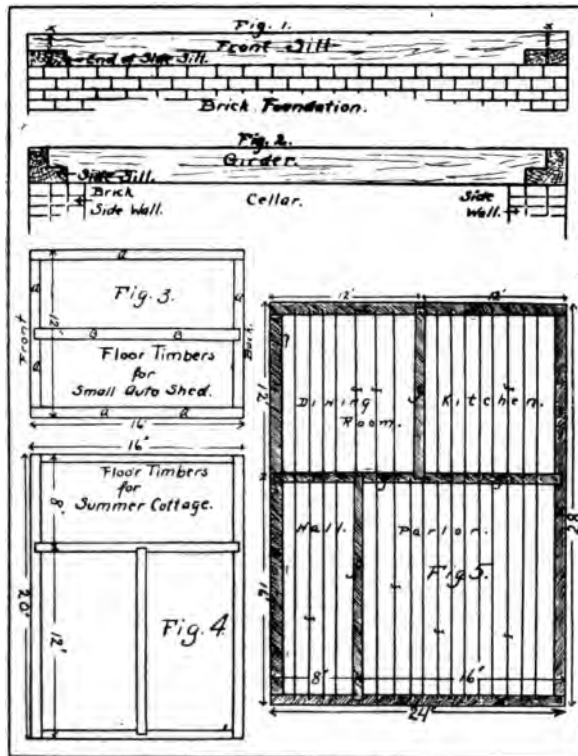
246 Main Street, Town.

Bought of BROWN, STONE & CO.

4 pc.	3" x 4" stock, 10 ft. lengths	?	?	bd. ft., at \$30.00 M.	11	?	?
40 pc.	2" x 3" stock, 12 ft. lengths	?	?	bd. ft., at 30.00 M.	6	?	?
32 pc.	2" x 8" stock, 15 ft. lengths	?	?	bd. ft., at 32.00 M.	1	?	?

Received Payment,

BROWN, STONE & CO.



## LESSON X.—FRAMING THE FLOORS OF SMALL BUILDINGS.

Figs. 3 and 4 in the diagram show part of the floor frame of a small building like an automobile shed or small barn. The first timbers laid on the stone or brick foundations are called sills (see a a a in Fig. 3). The timbers running across (B B) are girders. These sills are joined at the corners, as shown in Fig. 1), which is a "halving-joint," the front sill overlapping the side sills at the corners of the building. The two are held in place by a strong wooden peg (x). Fig. 2 shows how the girder, which helps sustain the weight of the building, is itself supported at the ends by resting on the foundation and being mortised into the side sills.

1. How long will each of the two side sills be in Fig. 3? How long the front and back sills? These being for a small structure may be only 6" x 6" stock. What does that mean?

2. Compute the number of board feet in both side sills. Both end sills.

3. How could the number of board feet in all four sills have been obtained in one example? Show.

4. The girder in Fig. 3 is 4" x 6" and 16 ft. long. Compute the board feet.

5. How much would the five timbers cost @ \$28 per M.? How much @ \$32 per M.?

6. In the second building (Fig. 4) the sills are 6" x 8" and the girders the same. Make a list of timber needed as follows, and compute the number of board feet for each different kind:—

2 6" x 8" sills    ? ft. long contains ? bd. ft.

2 6" x 8" sills    ? ft. long contains ? bd. ft.

1 6" x 8" girder 16 ft. long contains ? bd. ft.

1 6" x 8" girder 12 ft. long contains ? bd. ft.

7. Compute the total number of board feet and the cost @ \$30 per M.

**8.** If the price were  $16\frac{2}{3}\%$  higher what would the same lumber have cost?

Examine Fig. 5 carefully. Point out the sills and girders. The chief use of the girders is to sustain the interior weight of the building, and they are not supported by a foundation, as the sills are. What supports are used? (Look in your own cellars.) Where are they placed? Can you give any explanation of the arrangement of these girders? Explain the probable floor plan of the house, location of partitions, doors, etc. Girders are usually placed on edge to secure greater strength. (To find the reason try to bend your ruler flatwise and then edgewise.)

The other timbers (J J J) are floor joists, usually made of spruce and set 16 inches apart from centre to centre. When these have been set, the first flooring of boards is nailed on to give a surface to stand on before the side walls of the building are raised.

**9.** How long are the two side sills? The two end sills? The main girder? The back and front girders?

**10.** Fill in the figures needed in the following table:—

2 sills	6" x 8"	and 28 ft. long contain	—ft. B. M.
2 sills	6" x 8"	and 24 ft. long contain	—ft. B. M.
1 girder	6" x 8"	and 24 ft. long contains	—ft. B. M.
1 girder	6" x 8"	and 16 ft. long contains	—ft. B. M.
1 girder	6" x 8"	and 12 ft. long contains	—ft. B. M.
Total—ft. B. M.			

The floor joists are placed as indicated by the single lines in the diagram; they are placed on edge, and are mortised into the sills and girders. Those under the parlor would probably be ? feet long, under the kitchen and dining-room ? feet long?

**11.** Count the number used under the parlor and compute the number of bd. ft., using 2" x 8" stock.

**12.** In the same manner compute the number of bd. ft. necessary (a) under the kitchen, (b) under the dining-room, (c) under the hall.

**13.** Compute the total cost of the heavy timber (sills and girders) @ \$32 per M.

**14.** Total cost of joists @ \$30 per M.

**15.** The whole floor as framed is now covered with the first rough flooring. Compute the number of board feet needed. Compute cost @ \$28 per M.

### Estimating Cost of Labor.

When a contractor undertakes to build a house, he is called upon to give an estimate of the cost of the entire job. In order to do this he goes over the entire plan, estimating the cost of each detail much as we have done above. In estimating the probable cost of labor, the floor and other parts of the building are divided into "squares." A "square" is 100 square feet.

Illustration: In constructing the floor of a building 30 feet x 28 feet:—

$$\frac{30 \times 28}{100} = \frac{840}{100} = 8.4 \text{ squares.}$$

**16.** Find the number of "squares" in the floor of the house last studied. Estimating the cost of labor at \$1.50 per square for framing the floor and \$1.40 per square for boarding, what is the entire estimate for labor?

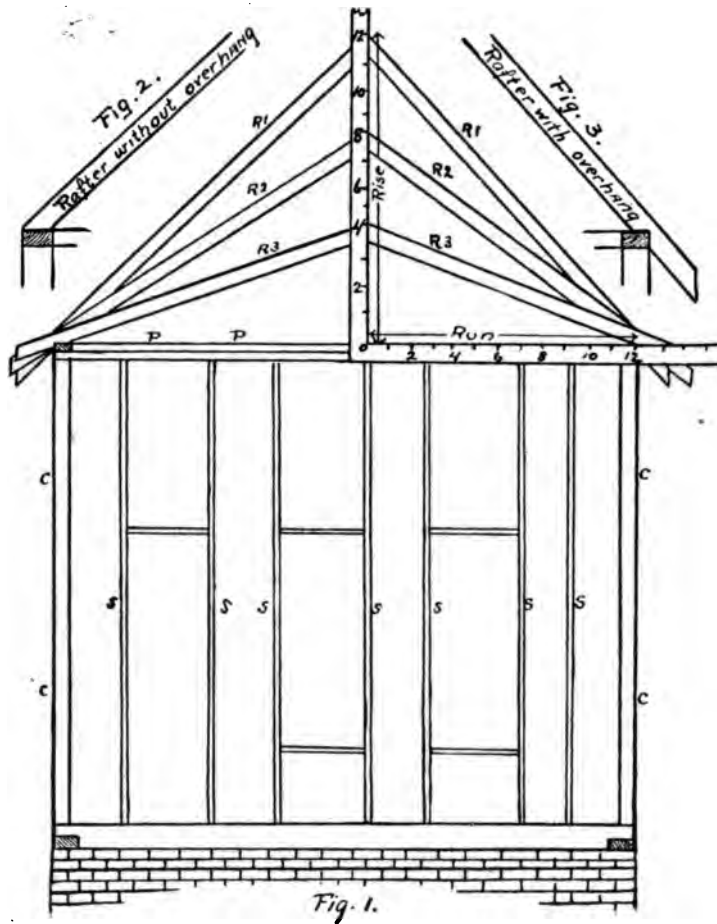
**17.** Estimate the cost of labor in framing a 28 ft. x 32 ft. floor at \$1.60 per square, and \$1.50 per square for laying first floor.

**18.** Estimate for 25 ft. x 30 ft. floor—framing @ \$1.75, flooring @ \$1.65.

**19.** If a carpenter is paid \$3.28 (Boston scale, 1906) per day of 8 hrs., and can lay 300 sq. ft. of rough floor, what is the cost per square?

**20.** If he can only lay 200 sq. ft., it brings the cost of labor up to what for 1 square?

**21.** Two carpenters working together, each paid \$3.50 per day of 8 hrs., can frame about 600 sq. ft. How many squares is this? What is the cost per square?



## LESSON XI.—WALLS AND ROOFS.

The walls of a house are framed by placing upright corner posts of 4" x 4" stock (c c) and studs (s s s) 2" x 4" pieces usually 16" apart. They are spiked to the sills below and to the "plate" (p p p) above, as shown in the diagram. Estimating the lumber for the side walls is rather more difficult on account of doors, windows, and projections.

The accompanying diagram shows three positions of the rafters (R R R), illustrating three "gable" roofs of different "pitch" or slant, with an imaginary carpenter's steel square enlarged so that inches have become feet. This will help us understand how carpenters (or boys and girls) can ascertain the proper length to saw rafters for any pitch of roof.

### Oral.

1. The "run" ( $\frac{1}{2}$  the width of the house) is how many feet? The "rise" (height of the roof) is how many feet in the highest roof ( $R^1$ )? Expressing the height of this roof as the numerator of a fraction and the whole width of the house as the denominator, we get  $\frac{12}{24}$ , which reduced is  $\frac{1}{2}$ . Such a roof we call a " $\frac{1}{2}$  pitch" roof.

2. What would be the height of a  $\frac{1}{2}$  pitch roof in a 30-foot building? 28-ft.? 36-ft.? 42-ft.? 26-ft.? 34-ft.?

3. The "run" and "rise" of the middle roof ( $R^2$ ) are what? Compare the "rise" with the whole width of the building and tell what the "pitch" is.

4. How high would a  $\frac{1}{3}$  pitch roof be in a building 18 ft., 42 ft., 36 ft., 21 ft., 25 ft., 30 ft., or 31 ft. wide?

5. The lowest position of the rafters ( $R^3$ ) would give a roof having what for "rise" and "run"? Decide what the "pitch" is.

6. Give the height of a  $\frac{1}{6}$  pitch roof in buildings of the following widths: 30 ft., 42 ft., 36 ft., 40 ft., 27 ft., 38 ft.

**Written Problems.**

**HOW DOES THE CARPENTER KNOW HOW LONG TO CUT HIS RAFTER FOR ANY PITCH ROOF ?**

If we could measure along the upper edge of the rafter ( $R^3$ ) from the point 4 ft. on the vertical arm of the imaginary steel square in the diagram to the point 12 ft. on the horizontal arm we should have the required length of the rafter, to which may be added a foot or more for overhang or eaves if desired. (See also Figs. 2 and 3.) As squares are not made so large as in the diagram, suppose we take one of ordinary size and measure the distance in *inches* from the 4-inch point to the 12-inch point. The distance will be about  $12\frac{1}{4}$  in.; the rafter would be approximately  $12\frac{1}{4}$  ft. long, or 12 ft. 8 in. If a foot is added for the eaves, they would, of course, be cut 13 ft. 8 in. long. (The cutting of rafters requires skill in the use of the steel square, but is easily learned, and can be done on the ground so as to fit perfectly when put in place.)

**1.** Use a steel square and a yard stick and find the approximate length of rafter  $R^2$  in the diagram, making no allowance for overhang.

**2.** How high would a  $\frac{1}{2}$  pitch roof on a 20-ft. building be? Lay the yardstick on a steel square so as to connect the 10" mark on the short arm with the 10" mark on the long. What is the approximate length of the rafter?

**3.** Ascertain the length of the rafter (without overhang) of a  $\frac{1}{4}$  pitch roof on the same building.

**4.** Compute the length of rafter (without eaves) in an 18-ft. building with a  $\frac{1}{6}$  pitch roof. A  $\frac{1}{2}$  pitch. A  $\frac{1}{3}$  pitch.



GROUP OF PUPILS MEASURING LUMBER.

## LESSON XII.—BOARDING AND SHINGLING ROOFS.

1. Compute area of "lean-to" roof 12' x 20'. How many board feet needed in boarding it in? What would they be worth at \$30 M?

2. Compute the cost of boards in the following "lean-to" roofs: 8 ft. x 20 ft. @ \$32 M, 8 ft. x 32 ft. @ \$28 M, 10 ft. x  $17\frac{1}{2}$  ft. @ \$39 M.

3. Board both slopes of gable roofs of the following dimensions:—

Ridge, 28 ft.; rafter, 20 ft.; cost of boards, \$31 M.

Ridge, 25 ft.; rafter, 18 ft.; cost of boards, \$31 M.

Ridge, 30 ft.; rafter, 24 ft.; cost of board, \$32 M.

4. If two men can lay 600 ft. of roofing boards in a day, how long will it take them to lay each of the roofs in problem 3? Count fractional parts of an hour as 1 hour. What will the cost of labor be in each case at \$3.28 for each man? (8 hr. day.)

5. Shingles are sold by the thousand. There are four bundles to the thousand. Laid 4 in. to the weather, that number of shingles would cover 111 sq. ft. Compute cost of shingles for following roofs. [In buying for each of the following gable (two slope) roofs, order a full 1,000 for any fraction left over]:—

(a) Rafter, 20; ridge, 30; cost @ \$3.50 per M.

(b) Rafter, 24; ridge, 32; cost @ \$4.00 per M.

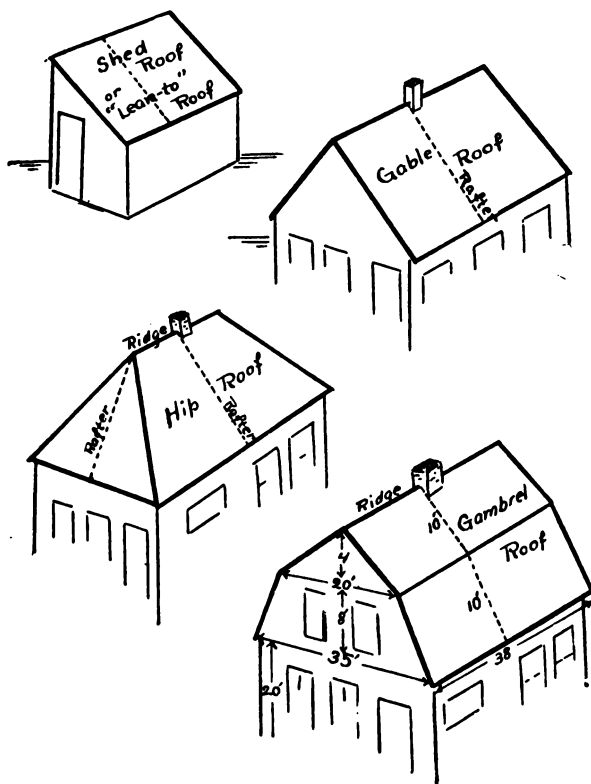
(c) Rafter, 16; ridge, 30; cost @ \$4.50 per M.

6. Estimate cost of shingles for following roofs, shingles laid  $4\frac{1}{2}$ " to weather, estimating 800 shingles to the square:—

(x) Rafter, 15; ridge, 25; cost @ \$3.00 M.

(y) Rafter, 20; ridge, 28; cost @ \$3.50 M.

(z) Rafter, 22; ridge, 30; cost @ \$4.00 M.



## HIP ROOFS.

In a hip roof without projecting windows we have two triangles at front and back, respectively, and two "trapezoids" on the sides. In a trapezoid the two parallel sides are sometimes referred to as the bases, large (B) and small (b).

## FORMULAE.

$$\text{Area of a triangle} = \frac{\text{altitude} \times \text{base}}{2} \text{ or } \frac{A \times B}{2}$$

$$\begin{aligned} \text{Area of trapezoid} &= \frac{1}{2} \text{ altitude} \times \text{sum of parallel sides;} \\ &\quad \text{or} \\ &\quad \frac{1}{2} A \times (B + b) \\ &\quad \text{or} \\ &\quad \frac{A \times (B + b)}{2} \end{aligned}$$

**7.** Compute the area of one side of the following hip roofs:—

Length at eaves, 30 ft.; ridge, 10 ft.; rafter, 18 ft.

Length at eaves, 24 ft.; ridge, 6 ft.; rafter, 16 ft.

Length at eaves, 28 ft.; ridge, 8 ft.; rafter, 16 ft.

**8.** Compute the area of one end of same roofs from following dimensions:—

Length at eaves, 26 ft.; length of central rafter, 18 ft.

Length at eaves, 20 ft.; length of central rafter, 16 ft.

Length at eaves, 24 ft.; length of central rafter, 16 ft.

**9.** Compute the number of 1,000 ft. of lumber needed to completely board in a hip roof if the longest rafter in each section is 20 ft., the ridge, 10 ft., the side eaves, 40 ft., and end eaves, 30 ft.

**10.** Compute the cost at \$35 M. Draw diagram and mark all dimensions plainly.

**11.** Find the number of 1,000 shingles, esti-

ating 800 to the square, buying even thousands, and paying \$3.50 per M.

**12.** Figure the cost of labor in boarding at \$1.50 per square, and cost of shingling at \$2.25 a square.

**13.** Total cost of labor and material in covering above roof.

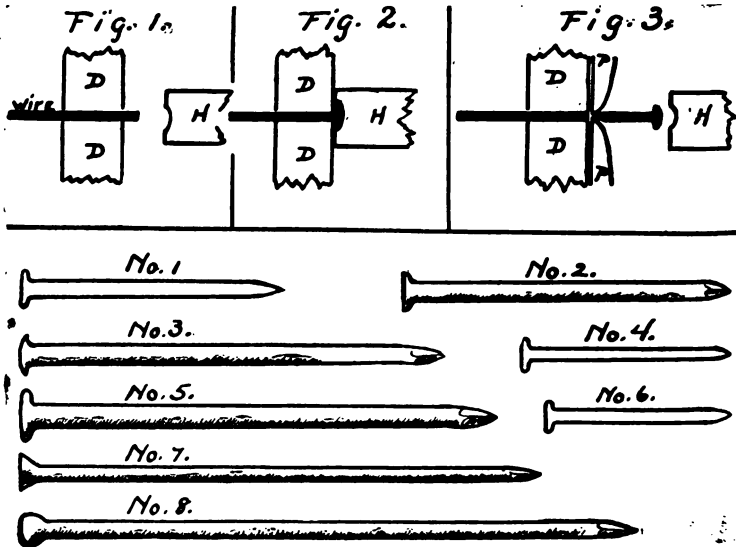
**14.** Each face of a plain gambrel roof without projections is what geometrical figure? There are how many? How find the area of one of the rectangles? How of the whole four?

**15.** Using the same figures for material and labor as above, compute the total cost of boarding in and shingling if the roof is 38 ft. long and each section is 10 ft. wide.

**16.** In boarding up the front of this house (without reduction for windows, etc.,) compute the area of each of the 3 sections from figures given in the sketch. What is the total area?

### LESSON XIII.—THE MANUFACTURE OF WIRE NAILS.

Study the diagram and describe the three steps in the cutting, pointing, and heading of wire nails. Note the two blades (P P) which come together in Fig. 3 as the hammer (H) is withdrawn, cutting the wire and pointing the nail at one stroke.



Measure the length of each nail shown in the preceeding cut, and express the results to the nearest quarter or eighth of an inch.

No. 1, a barrel nail,	? inches
No. 2, a 5d. shingle nail,	? "
No. 3, a 7d. clinch nail,	? "
No. 4, a 3d. fine nail,	? "
No. 5, an 8d. common nail,	? "
No. 6, a lining nail,	? "
No. 7, a 9d. flooring nail,	? "
No. 8, a 12d. finishing nail,	? "

1. Notice the distance which the wire projects beyond the face of the dies (DD) in Fig. 1. This is flattened to make the head of the nail. How does the length of the wire of which one nail is made compare with the length of the resulting nail? If  $\frac{1}{8}$  in. of stock (wire) is flattened into the head of the nail, what is the approximate length of wire used in making No. 6? (1 inch +  $\frac{1}{8}$  in. = 1  $\frac{1}{8}$  in. wire.)

2. Allowing this amount of wire for each nail, how many such nails will one foot of wire make? (Express fractional remainders as decimals of one place in all of these problems.)

3. Allowing the same amount of head stock in No. 4, what is the total length of wire required for each nail? How many such nails will 1 foot of wire make?

4. Nails the size of No. 2 would require about  $\frac{1}{8}$  in. of wire for the head. Compute the length of wire per nail and the number of nails per foot as before.

5. It takes 44 ft of the wire of which No. 1 is made to weigh 1 pound. What would a mile of such wire weigh? Could you lift that amount?

6. One pound of wire for making No. 6 would contain 129 feet. How much would a mile of this weigh? How does this compare with your own weight?

7. If 1 pound of wire for No. 4 contains 73 feet, and the number of nails made from every foot of it as found in problem 3, how many nails would a pound of wire make?

8. Allowing  $\frac{1}{8}$  in. for head stock in No. 2, how many nails could be made from 1 pound of wire if 34 ft. are contained in that amount?

**9.** Allow  $\frac{3}{16}$  in. for head stock in No. 3 and compute the length of wire per nail and the number of nails per foot of wire.

**10.** If 26 ft. of No. 3 wire weigh one pound, compute the weight of a mile of such stock wound on a reel ready for cutting.

**11.** How many No. 3 nails would the mile of wire produce? (Use answer of problem 9.)

**12.** It is estimated that about 7 per cent. of the weight of the nail is wasted when the point is cut as shown in Fig. 3. If a mile of wire weighed 203 pounds, how many pounds of stock has been wasted by the time it has been cut into nails? About how much ought the resulting nails to weigh?

**13.** If a mile of wire of another size weighs 147 pounds, how many pounds of this will be wasted, and what will be the approximate weight of the resulting nails?

**14.** If a reel carries 125 pounds of wire when ready for the machine, what will be the approximate weight of the nails into which it is made?

**15.** Allow  $\frac{1}{4}$  in. head stock in No. 7 and compute the number of such nails to the foot.

**16.** Allow  $\frac{3}{16}$  in. for head stock in No. 8 and compute the number per foot.

**17.** Nail No. 7 as shown in scale drawing is what per cent. of the length of No. 8?

**18.** The wire in No. 7 (see problem 15) was what per cent. longer than the resulting nail?



WHERE ACCURACY COUNTS.

[By permission of the United Shoe Machinery Co.]

## LESSON XIV.—A STUDY OF WAGES.

### Part 1.

#### Wages in Different Trades.

In the cutting room of a shoe factory the men are paid by the day.

The following schedule of cutting-room wages was agreed upon by the officials of the Labor Union and a Massachusetts shoe manufacturer in 1909. Find out as much as you can about the different processes mentioned. Compute the wages per hour for each:—

NAME OF PROCESS.	Wages per Day of 9 Hours	Wages per Hour
1. Cutting vamps	\$3.00	?
2. Top cutting by hand	2.50	?
3. Clicking machine on outsides	3.50	?
4. Crimping	2.25	?
5. Marking lining	2.00	?
6. Dieing out on block	1.75	?
7. Compute the wages of W. S. Brown, vamp cutter, who only works 7 hours Monday.		
8. Wage of L. R. Condon, top cutter, who works only 8 hours the same day?		
9. Wage of O. B. Downey, on clicking machine, $4\frac{1}{2}$ hours?		
10. Wage of A. R. Eames, crimper, $7\frac{1}{4}$ hours?		
11. Week's wage of B. C. Hudson, marking linings, worked just half time for six working days of this week?		
12. Week's wage of A. B. Jones dieing on block, who worked 32 hours last week?		
13. Compare the wages in the following list with the above factory wages. State reasons for the difference. Why an 8-hour day for the outdoor worker?		
14. What is the hourly wage of the stone mason? A full week's pay is what?		

WAGES PER DAY OF EIGHT HOURS, BOSTON, MASS., 1906.	
Carpenters, \$3.28.	Plasterers, \$5.00.
Stone masons, \$4.50.	Plasterer's helpers, \$3.00.
Brick masons, \$4.80.	Lathers, \$4.50.
Hod carriers, \$2.40.	Tile setters, \$4.80.

Carpenters, \$3.28.	Plasterers, \$5.00.
Stone masons, \$4.50.	Plasterer's helpers, \$3.00.
Brick masons, \$4.80.	Lathers, \$4.50.
Hod carriers, \$2.40.	Tile setters, \$4.80.

**15.** How much more would a carpenter get for a full week's work than a cutter of vamps?

**16.** A stone mason makes what per cent more per day than a cutter of tops? Is his job as much more desirable as this per cent. would indicate? Reasons?

**17.** Compute the per cent. of increase in the wage of a stone mason per day over that of a hod-carrier.

**18.** Ditto—Brick mason over stone mason.

**19.** Ditto—Lather over plasterer's helper.

**20.** Ditto—Plasterer over lather.

## Part 2. The Time Clock.

The time clock in a factory records the time when each worker arrives and leaves. (Learn how.) The bookkeeper keeps the record of each man's day to the nearest quarter of an hour. If he worked 8 hours and 20 minutes, he would be paid for 8  $\frac{1}{4}$  hours; if he worked 8 hours, 25 minutes, he would be paid for 8  $\frac{1}{2}$  hours' work.

**21.** Compute the wages paid for each of the following day's work:—

- (a) 7 hours, 15 minutes @ 35c. per hour.
- (b) 5 hours, 20 minutes @ 25c. per hour.
- (c) 6 hours, 40 minutes @ 33  $\frac{1}{3}$ c. per hour.
- (d) 8 hours, 50 minutes @ 36  $\frac{1}{3}$ c. per hour.

**22.** Rule a page like the following, and make out the weekly pay roll for the seven employees indicated below:—

**PAY ROLL OF  
CONSOLIDATED BOOT AND SHOE COMPANY.  
Room—Cutting Department.      Week—January 3d to 8th, 1910.**

Names of Employees.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Total No. Hours.	Wage per Hour.	Am't of Pay.
Ames, A. O..	9 hr.	9 hr.	8½ hr.	9 hr.	9 hr.	3½ hr.	?	30c.	?
Brown, S. R.	7½ hr.	8 hr.	9 hr.	5½ hr.	7½ hr.	8 hr.	?	25c.	?
Cannon, O. E.	5 hr.	4 hr.	6½ hr.	5½ hr.	7 hr.	3½ hr.	?	22 2-9c.	?
Downe, M. E.	9 hr.	9 hr.	9 hr.	9 hr.	9 hr.	5 hr.	?	30 5-9c.	?
Frost, W. H.	8 hr.	7½ hr.	8¾ hr.	9 hr.	7½ hr.	6½ hr.	?	41 2-3c.	?
Holmes, J. H.	9 hr.	8 hr.	7 hr.	7 hr.	3 hr.	3 hr.	?	38 8-9c.	?
Lane, R. O..	9 hr.	9 hr.	8¾ hr.	8½ hr.	9 hr.	4½ hr.	?	33 1-3c.	?

### Part 3. Working by the Piece.

In the shoe factory most workers receives wages according to the amount of work done. They are said to work "by the piece." Discuss division of labor, its advantages and disadvantages, also advantages and disadvantages of working "by the piece."

A person working at any of the following jobs in the stitching room would receive the amount specified for each 24 pairs done by him in a day:—

- Job A. Stitching top facings, \$.04.
- Job B. Hooking, \$.035.
- Job C. Stitch top and undertrim, \$.14.
- Job D. Eyeletting, \$.025.
- Job E. Seam toe lining, \$.03.
- Job F. Stitch label, \$.05.

**23.** How many 24-pair lots of job A must be done if the operator is to make \$1.72 in a day? \$1.84? \$2.12?

**24.** If the operator in job B earned \$2.66 Monday, how many 24-pair lots did he do?

**25.** The operator in job C did 17 24-pair lots Monday, 16 Tuesday, 18 Wednesday, 20 Thursday, 15 Friday, and 12 Saturday. What are his week's wages?

**26.** How many 24-pair lots would the operator in job D have to finish in a day if he made as much as the operator in job E, who did 90 24-pair lots?

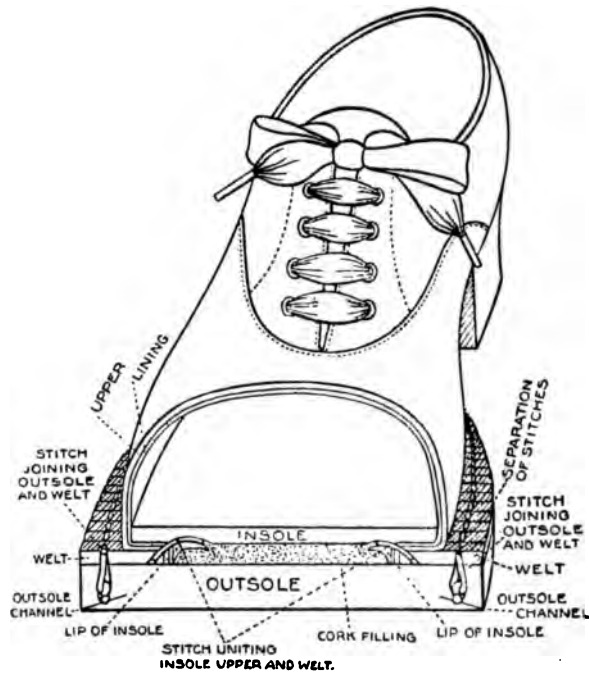
**27.** If operator on job F handled the 85 lots in a day, he would make how much more than operator on job E, handling the same number?

**28.** The prices paid for different parts of the process of finishing black bottom shoes range as follows: (a) 1 1-2c., (b) 3c., (c) 4c., (d) 6c., (e) 7 c., (f) 7 1-2c., and (g) 10c. per 24-pair lot. What decides the amount to be paid for each kind of work?

**29.** Job (b) receives what per cent. more than (a)? (c) than (b)? (d) than (c)?

**30.** Job (f) than (e)? (g) than (f)? (g) than (e)?

**31.** The highest price paid for work done on a 24-pair lot in the making room was 17 cents; the lowest, 1 1-2 cents. How many times as many lots would the latter workman have to do to receive as high a day's pay as the former?



**Cross section of a Goodyear Welt Shoe  
showing the different parts and  
their relation to each  
other**

## LESSON XV.

### How the Price of a Pair of Shoes is Determined.

[From data obtained by Superintendent C. W. Humphrey of Rochester, Mass.]

The manufacture of a pair of shoes from tanned hides, cloth, etc., begins in the cutting room, where the different parts which constitute the "uppers" are cut. In the manufacture of a certain grade of shoe the cost of the stock (leather, cloth, etc.), of which the vamp, tip, foxing, top, lining, inside back stay, and tongues are made, has been figured very carefully. The cost per pair was, respectively, 23c., 7c., 7c., 22½c., 2½c., 1c., 2c.

1. What is the total cost for all parts for one pair?

2. In like manner the cost of labor in cutting and sorting these different parts was estimated as follows: \$.023, \$.01, \$.002, \$.002, \$.01, \$.043. What was the total cost per pair for labor in cutting room?

3. In the stitching room these different parts are stitched together so as to form the upper part of the shoe (without sole). There are at least 25 different parts to the process, each operative doing one part only. He or she becomes in this way very skilful, and works with great rapidity. The cost of each of these steps is given as follows, each amount being for 1 dozen pairs: \$.01, \$.02, \$.015, \$.0075, \$.02, \$.01, \$.0175, \$.06, \$.10, \$.025, \$.01065, \$.08, \$.015, \$.08, \$.10, \$.015, \$.0125, \$.0266, \$.0333, \$.015, \$.02, \$.04, \$.24, \$.02, \$.24. What is the total cost for labor on the dozen pairs? On one pair?

4. The cost of extra stock used (called "findings"), consisting of strap, hooks, eyelets, and box toe is as follows: \$.0034, \$.0208, \$.007, \$.04 per pair. What is the total cost of stitching-room "findings" per pair?

5. In the lasting room the uppers (now sewed together) and the counter and innersole are fastened to the last giving shape to the shoe. The cost of each process was as follows for 1 dozen pairs: \$.03, \$.12, \$.12, \$.28, and \$.02. Total cost for lasting 1 dozen pair? Cost for lasting 1 pair?

6. The stock used in this room are counters, insole, and shellac, costing respectively: \$.0625, \$.10, \$.0075 per pair. Total cost of these lasting-room findings?

7. In the bottoming room there are twenty or more processes in assembling top and bottoms, shaping soles, heels, etc. The labor for each of the processes cost the following amounts for 1 dozen pairs: \$.015, \$.075, \$.15, \$.085, \$.02, \$.04, \$.01, \$.04, \$.02, \$.12, \$.015, \$.18, \$.01, \$.01, \$.03, \$.03, \$.08, \$.0375, \$.04, \$.02, \$.10, \$.18, \$.05, \$.18, \$.02. Total cost per dozen pairs? Total cost per pair?

8. In the finishing room there are sixteen more operations before the soles and heels have the high degree of finish which the public demand. This costs \$.48 per dozen pair, or how much for 1 pair?

9. In the treeing room, some eight more operations follow, in which the shoes are finished, cleaned, and packed, all of which costs \$.50 for 1 dozen pair, or what for 1 pair?

**10.** The stock which has been used in these later operations consists of the out soles @ \$.25 per pair, heels @ \$.10 per pair, and other items, including pasteboard boxes and wooden packing cases, costing respectively, \$.0672, \$.0025, and \$.0375 per pair. This would add how much to the cost of stock for each pair of shoes?

**11.** This shoe sells to the wholesale dealer for \$2.25 per pair. It is estimated that nails, thread, blacking, etc., cost 4% of this wholesale price. How much?

**12.** Heating, light, rent, insurance, office work, advertising, carting, and freight cost 6% of the whole sale price. How much?

**13.** Salesmen's salaries and traveling expenses amount to 5% of the wholesale price. How much?

**14.** Carefully record the items obtained above on a sheet of paper arranged as on the next page. You have already obtained the first thirteen items. Compute the last three.

Note.—The figures given above were exact for the grade of shoe manufactured at the date when the investigation was made. The increasing cost of material and labor would change these amounts; the better quality shoes would also cost more; but the general features of the above data remain relatively the same,

**ITEMIZED COST OF STOCK AND LABOR IN ONE  
PAIR OF CHEAP GRADE SHOES.**

Cost of stock used in cutting room,	? per pair.
Cost of labor in cutting room,	? per pair.
Labor in stitching room,	? per pair.
Cost of stitching room "findings"	? per pair.
Cost of labor in lasting room,	? per pair.
Cost of lasting room "findings,"	? per pair.
Cost of labor in bottoming room,	? per pair.
Cost of labor in finishing room,	? per pair.
Cost of labor in treeing room,	? per pair.
Cost of stock used in bottoming, finishing and treeing,	? per pair.
Cost of extra findings ( $\frac{1}{4}$ % of wholesale price),	? per pair.
Cost of factory expenses (6 % of wholesale price),	? per pair.
Cost of selling (5 % of wholesale price),	? per pair.
<hr/>	
Total cost per pair to manufacturer,	?
Gain on each pair sold at wholesale,	?
What per cent. profit does the manufacturer make?	?

**ANSWERS**  
**TO**  
**WRITTEN PROBLEMS**

**NOTE:** A few answers will vary slightly according as insignificant fractions are retained or discarded in problems containing several steps. Here the teacher must use her own judgment as to what she shall require of the class.

## ANSWERS TO WRITTEN PROBLEMS.

### Lesson I.

- |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
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| <p><b>1.</b> (a) 54 sq. in.<br/>           (b) 96 sq. in.<br/>           (c) 140 sq. in.<br/>           (d) 187 sq. in.<br/>           (e) 288 sq. in.<br/>           (f) 450 sq. in.<br/>           (g) 540 sq. in.</p> <p><b>4.</b> 12 sq. in.</p> <p><b>5.</b> <math>13\frac{3}{4}</math> sq. in.</p> <p><b>6.</b> <math>\frac{1}{2}</math> sq. in. more.</p> <p><b>7.</b> 27 sq. in. difference.</p> <p><b>8.</b> <math>18'' \times 34''</math>; <math>83\frac{1}{8}</math> sq. in.<br/>                 waste; 40c.</p> <p><b>9.</b> <math>16'' \times 30''</math>; <math>45\frac{3}{8}</math> sq. in.<br/>                 waste.</p> <p><b>10.</b> (a) <math>11'' \times 17''</math>; <math>25\frac{9}{16}</math>;<br/>                 13c.<br/>           (b) <math>8'' \times 10''</math>; <math>16\frac{5}{8}</math>; 5c<br/>           (c) <math>10'' \times 14''</math>; <math>16\frac{1}{4}</math>; 9c<br/>           (d) <math>12'' \times 24''</math>; 12; 19c.<br/>           (e) <math>26'' \times 13\frac{1}{2}''</math>; 26;<br/>                 24c.<br/>           (f) <math>17'' \times 11''</math>; <math>23\frac{1}{4}</math>;<br/>                 13c.</p> | <p><b>8.</b> (a) <math>6\frac{3}{4}</math> in.<br/>           (b) <math>6\frac{5}{8}</math> in.<br/>           (c) <math>7\frac{1}{2}</math> in.<br/>           (d) <math>6\frac{5}{8}</math> in.<br/>           (e) <math>6\frac{3}{8}</math> in.<br/>           (f) <math>7\frac{1}{2}</math> in.</p> <p><b>9.</b> (a) <math>1\frac{1}{8}</math> in.<br/>           (b) <math>3\frac{7}{8}</math> in.<br/>           (c) <math>2\frac{7}{8}</math> in.<br/>           (d) <math>\frac{7}{8}</math> in.<br/>           (e) <math>1\frac{5}{8}</math> in.<br/>           (f) <math>2\frac{3}{8}</math> in.</p> <p><b>10.</b> (a) <math>2\frac{3}{8}</math> in.<br/>           (b) <math>2\frac{1}{4}</math> in.<br/>           (c) 2in.<br/>           (d) <math>\frac{5}{8}</math> in.</p> <p><b>11.</b> <math>1\frac{3}{8}</math> in.<br/> <math>9\frac{1}{2}</math> in.<br/> <math>5\frac{1}{8}</math> in.</p> <p><b>12.</b> (a) <math>\frac{7}{8}</math> in.—<math>3\frac{3}{8}</math> in.<br/>           (b) <math>\frac{5}{8}</math> in.—<math>5\frac{5}{8}</math> in.<br/>           (c) <math>\frac{3}{8}</math> in.—<math>4\frac{1}{2}</math> in.<br/>           (d) <math>\frac{3}{4}</math> in.—<math>5\frac{1}{8}</math> in.<br/>           (e) <math>1\frac{3}{8}</math> in.—<math>3\frac{3}{4}</math> in.<br/>           (f) <math>\frac{1}{2}</math> in.—<math>3\frac{1}{8}</math> in.</p> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### Lesson II.

- 6.**  $2\frac{1}{8}$  in.
- 7.** (a)  $4\frac{1}{2}$  in.  
 (b)  $2\frac{3}{8}$  in.  
 (c)  $10\frac{1}{8}$  in.  
 (d)  $5\frac{7}{8}$  in.  
 (e)  $6\frac{1}{8}$  in.  
 (f)  $10\frac{1}{16}$  in.

### Lesson III.

- 3.** 5 ft.
- 4.** 40c.,  $32\frac{1}{2}$  or 33c.,  $26\frac{1}{2}$   
           or 26c.
- 5.** (a)  $46\frac{1}{4}$  or 3 ft. 10 in.  
 (b) 74 in. or 6 ft. 2 in.  
 (c) 55 ft. or 4 ft. 7 in.

(d)  $4\frac{1}{2}$  in. or 3 ft.  $5\frac{1}{2}$  in.

4,400 gro.

Mr. M.—59,400;

475,200;

3,300 gro.

7. (a)  $\frac{1}{4}$  ft. 10 in. or  $4\frac{1}{8}$  ft.

(b)  $\frac{1}{4}$  ft. 3 in. or  $4\frac{1}{2}$  ft.

(c) 5 ft. 3 in. or  $5\frac{1}{4}$  ft.

(d) 5 ft.  $5\frac{1}{2}$  in. or  $5\frac{1}{4}$  ft.

(e)  $\frac{1}{4}$  ft.  $3\frac{1}{2}$  in. or  $4\frac{7}{8}$  ft.

(f) 6 ft.  $\frac{1}{2}$  in. or  $6\frac{1}{4}$  ft.

8. (a)  $10\frac{1}{2}$  in. x  $5\frac{1}{2}$  in.

(b)  $10\frac{1}{2}$  in. x  $7\frac{1}{2}$  in.

(c)  $12\frac{1}{2}$  in. x  $8\frac{1}{2}$  in.

(d)  $10\frac{1}{4}$  in. x  $8\frac{3}{4}$  in.

9. L.,  $14\frac{3}{4}$  in., W.,  $8\frac{3}{4}$  in.

10. 11 in. x 15 in.

11. 11 in. x  $15\frac{1}{2}$  in.

Cut from 11 in. x 17 in.

Cut  $1\frac{1}{2}$  in. off end.

12. (a) 6 ft. 5 in.

(b) 3 ft. 7 in.

(c) 10 in. x  $16\frac{1}{2}$  in.

(d)  $10\frac{1}{2}$  in. x 17 in.

(e) 11 in. x 17 in.

(f)  $8\frac{1}{2}$  sq. in.

#### Lesson IV.

1. 5,400; 43,200.

2. 475,200.

3. 3,300 gro.

4. 4,200 gro.

5. Mr. J.—51,300;

410,400;

2,850 gro.

Mr. S.—6,600;

633,600;

#### Lesson V.—Part 1.

1. 60c.

2. 26c.

3. 93c.

4. 72c.

5. 50c.

6. (a) 31c.

(b) \$2.81.

(c) \$12.00.

(d) \$1.12.

(e) \$2.03.

(f) 67c.

#### Part 2.

1. 8.

2. 8; 64.

3. 2 in. x  $2\frac{3}{4}$  in.; 110 cards.

4.  $2\frac{1}{2}$  in. x  $3\frac{1}{2}$  in.; 80.

5.  $2\frac{3}{4}$  in. x  $\frac{1}{2}$  in.; 63.

6.  $2\frac{1}{2}$  in. x  $4\frac{5}{8}$  in.; 48.

7.  $3\frac{1}{2}$  in. x  $5\frac{1}{4}$  in.; 35.

8. 5.

9. 7.

10. 16.

11. 21.

#### Part III.

2. 8.

3. 13.

4. Flat packet.

Packet folio.

- Double royal. 3. 2 bds.  
 5. 250. 4. 5 strips removing.  
 6. (a) Double cap; 8. 2 in. by rip saw.  
 (b) Folio, 8; double 5. 12 run. ft.  
 folio, 16. 15 run. ft.  
 7. (a) Folio, 250. 2 8-ft. boards.  
 D. folio, 125. 6.  $13\frac{1}{8}$  ft.; buy 14 ft.  
 (b) Demy, 250. board.  
 (c) Medium, 125. 7.  $22\frac{1}{2}$  in.  
 8.  $24\frac{1}{4}$  in.  
 9.  $17\frac{7}{8}$  in.  
 10.  $9\frac{1}{4}$  in.  
 11.  $24\frac{1}{4}$  in.  
 12.  $21\frac{1}{4}$  in.  
 13. 23 in.

**Lesson VI.**

1. 4 lengths; 12 in. waste.  
 2. Less; 24 in. waste.  
 3. 14 ft.  
 4. 6 l.; 6 in. w.  
 5. 9 ft. or 18 ft.  
 6. 4 strips (waste).  
 7. 10 in.  
 8. 4.  
 9. 8 in.  
 10. 5;  $\frac{5}{7}$  of strip; about  $1\frac{1}{4}$  in.  
 11.  $1\frac{7}{8}$  in.  
 12.  $\frac{5}{8}$  in.  
 13. 4.  
 14. 8.  
 15.  $1.7+$ .  
 16. 150.  
 17. More.  
 18. 25 in.; 4,320.  
 19. 2,454.5.

**Lesson VII.**

1. 4.  
 2. 6.

**Lesson VIII.**

1. 9.  
 2. 10.  
 3. 7;  $3\frac{1}{2}$  in waste.  
 7;  $15\frac{1}{2}$  in. waste.  
 9;  $4\frac{1}{2}$  in waste.  
 4. 11;  $2\frac{1}{2}$  in waste.  
 11;  $12\frac{1}{2}$  in. waste.  
 12; 6 in. waste.  
 5.  $\frac{1}{8}$  in.  
 6.  $20\frac{1}{16}$  in.  
 7.  $17\frac{7}{8}$  in. before.  
 $17\frac{5}{8}$  in. after.  
 8. (a)  $23\frac{1}{16}$  in.;  $23\frac{7}{16}$  in.  
 (b)  $17\frac{7}{8}$  in.;  $17\frac{3}{8}$  in.  
 (c)  $14\frac{3}{8}$  in.;  $14\frac{1}{8}$  in.  
 9. (a)  $21\frac{1}{4}$  in.;  $20\frac{3}{4}$  in.  
 (b)  $21\frac{7}{8}$  in.;  $20\frac{1}{8}$  in.  
 (c)  $16\frac{1}{2}$  in.; 16 in.

- (d)  $13\frac{1}{2}$  in.;  $12\frac{5}{8}$  in.
- 10.**  $\frac{1}{2}$  in.; 21 in.
- 11.** (a)  $1\frac{5}{8}$  in.  
(b)  $2\frac{1}{2}$  in.  
(c)  $1\frac{1}{8}$  in.  
(d)  $\frac{7}{8}$  in.
- 12.**  $13\frac{1}{4}$  in.
- 13.** (a)  $1\frac{1}{2}$  in.  
(b)  $1\frac{3}{8}$  in.  
(c)  $1\frac{1}{8}$  in.  
(d)  $\frac{7}{8}$  in.
- 14.**  $\frac{11}{16}$  in.
- 15.**  $\frac{2}{3}$  in.
- 16.**  $\frac{11}{16}$  in.
- 17.**  $\frac{7}{8}$  in.
- 18.** 12 in.
- 19.** (a)  $23\frac{1}{2}$  in.  
(b)  $35\frac{5}{8}$  in.  
(c)  $31\frac{1}{2}$  in.  
(d)  $33\frac{1}{2}$  in.
- 20.**  $19\frac{1}{4}$  in.
- 21.** (a)  $24\frac{13}{16}$  in.  
(b)  $30\frac{1}{4}$  in.  
(c)  $30\frac{1}{4}$  in.
- 12.** 20 bd. ft.
- 13.** 8 sq. ft.  
48 bd. ft.
- 14.** 80 bd. ft.
- 15.** The same.
- 16.** The same.
- 18.** 60 bd. ft.
- 19.**  $133\frac{1}{3}$  bd. ft.
- 20.** 105 bd. ft.
- 21.** 640 bd. ft.
- 22.** 168 bd. ft.
- 23.** 100 bd. ft.
- 24.** 648 bd. ft.
- 25.** 576 bd. ft.
- 26.** 896 bd. ft.
- 27.** \$75.00.
- 28.** \$25.60.
- 29.** \$18.00
- 30.** \$44.52.
- 31.** \$5.60.
- 32.** \$3.46.
- 33.** \$28.88.

## Lesson X.

- Lesson IX.**
- 2.** The same.
- 3.**  $\frac{1}{2}$  as many.  
 $\frac{2}{3}$  as many.
- 4.** 5, 9,  $7\frac{1}{2}$ , 8, 10, 6,  $6\frac{1}{2}$  bd ft.
- 5.**  $2\frac{2}{3}$ , 6,  $6\frac{2}{3}$ ,  $5\frac{1}{3}$ , 5, 4,  $4\frac{1}{3}$
- 9.** 8 sq. ft.; 16 bd. ft.
- 10.**  $21\frac{1}{3}$  bd. ft.
- 11.** 16 bd. ft.
- 2.** 96 bd. ft.  
72 bd. ft.
- 3.** 168 bd. ft.
- 4.** 32 bd. ft.
- 5.** \$5.60; \$6.40.
- 6.** 400 bd. ft.
- 7.** \$12.00.
- 8.** \$14.00.
- 9.** See next example.
- 10.** 624 bd. ft.

- |     |                              |                 |
|-----|------------------------------|-----------------|
| 11. | 256 bd. ft.                  | (c) \$40.50.    |
| 12. | K. = 128 bd. ft.             | 6. (x) \$18.00. |
|     | D. R. = 112 bd. ft.          | (y) \$31.50.    |
|     | H. = $85\frac{1}{3}$ bd. ft. | (z) \$44.00.    |
| 13. | \$19.97.                     | 7. 860 sq. ft.  |
| 14. | \$17.44.                     | 240 sq. ft.     |
| 15. | \$18.82.                     | 288 sq. ft.     |
| 16. | \$19.49.                     | 8. 234 sq. ft.  |
| 17. | \$27.78.                     | 160 sq. ft.     |
| 18. | \$25.50.                     | 192 sq. ft.     |
| 19. | \$1.09.                      | 9. 1.6 M.       |
| 20. | \$1.64.                      | 10. \$56.00.    |
| 21. | \$1.17.                      | 11. \$45.50.    |

**Lesson XI.**

1. 14 ft. 5 in.
2. 10 ft.; 14 ft. 2 in.
3. 11 ft. 2 in.
4. 9 ft. 6 in.
- 12 ft. 9 in.
- 10 ft. 10 in.

**Lesson XII.**

1. 240 bd. ft.  
\$7.20.
2. \$5.12.  
\$7.17.  
\$5.25.
3. \$34.72.  
\$27.00.  
\$46.08.
4. 1 d. 7 hr. (\$12.30).  
1 d. 4 hr. (\$9.84).  
2 d. 4 hr. (\$16.35).
5. (a) \$38.50.  
(b) \$56.00.

12. \$24.00 boarding.  
\$36.00 shingling.
13. \$161.50.
15. \$155.70.
16. 960 sq. ft.

**Lesson XIII.**

2. 11.3.
3. 10.1.
4.  $1\frac{7}{8}$ "; 6.4.
5. 120 lb.
6. 40.9 lb.
7. 737.3.
8. 217.6.
9.  $2\frac{7}{8}$ "; 4.9.
10. 203.1 lb.
11. 25,872.
12. 14.21 lb.  
188.79 lb.
13. 10.29 lb.  
136.71 lb.
14. 116.25 lb.

- |            |                      |            |          |
|------------|----------------------|------------|----------|
| <b>15.</b> | $\frac{1}{4}$ nails. | <b>23.</b> | \$14.39. |
| <b>16.</b> | 3.5 nails.           |            | \$16.25. |
| <b>17.</b> | $84\frac{1}{3}\%$ .  | <b>24.</b> | 76.      |
| <b>18.</b> | $9\frac{1}{11}\%$ .  | <b>25.</b> | 13.72.   |

**Lesson XIV.**

- |           |                          |            |                     |
|-----------|--------------------------|------------|---------------------|
| <b>1.</b> | $33\frac{1}{3}\text{c.}$ | <b>26.</b> | 108.                |
| <b>2.</b> | $27\frac{1}{4}\text{c.}$ | <b>27.</b> | 1.70.               |
| <b>3.</b> | $38\frac{5}{8}\text{c.}$ | <b>29.</b> | 100%.               |
| <b>4.</b> | 25c.                     |            | $33\frac{1}{3}\%$ . |
| <b>5.</b> | 22c.                     |            | 50%.                |
| <b>6.</b> | 19c.                     | <b>30.</b> | $7\frac{1}{4}\%$ .  |
| <b>7.</b> | \$2.33.                  |            | $33\frac{1}{3}\%$ . |
| <b>8.</b> | \$2.22.                  |            | $42\frac{1}{2}\%$ . |
| <b>9.</b> | \$1.75.                  | <b>31.</b> | $11\frac{1}{3}\%$ . |

**10.** \$1.81.**11.** \$6.00.**12.** \$6.22.**14.**  $56\frac{1}{4}\text{c.}$   
\$27.00.**15.** \$1.68.**16.** 80%.**17.**  $87\frac{1}{2}\%$ .**18.**  $6\frac{3}{4}\%$ .**19.** 50%.**20.**  $11\frac{1}{8}\%$ .**21.** (a) \$2.54.

(b) \$1.31.

(c) \$2.25.

(d) \$3.16.

**22.** \$14.40.

\$11.38.

\$7.00.

\$15.28.

\$19.69.

**Lesson XV.**

- |            |                         |
|------------|-------------------------|
| <b>1.</b>  | \$ .65.                 |
| <b>2.</b>  | \$ .09.                 |
| <b>3.</b>  | \$1.23305.              |
|            | \$ .10275.              |
| <b>4.</b>  | \$ .0712.               |
| <b>5.</b>  | \$ .57.                 |
|            | \$0475.                 |
| <b>6.</b>  | \$ .17.                 |
| <b>7.</b>  | \$1.5575 per doz. pr.   |
|            | \$ .1298 per pr.        |
| <b>8.</b>  | \$ .04.                 |
| <b>9.</b>  | \$ .0416+.              |
| <b>10.</b> | \$ .4572.               |
| <b>11.</b> | \$ .09.                 |
| <b>12.</b> | \$ .135.                |
| <b>13.</b> | \$ .1125.               |
| <b>14.</b> | Cost per pr., \$2.137+. |
|            | Gain per pr., \$ .112+. |
|            | Per cent gain, 5+%.     |

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